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ABSTRACT

A study was designed to investigate the complex interrelationship of factors that affect university students' academic achievement. The study used a sample population of 72 students who were enrolled in first year Nursing and Teacher Education courses in 1991 at the Flinders University of South Australia. From data gathered over 2 years, a two-wave path model was constructed to permit examination of the development of the student's learning processes over time and in conjunction with other antecedent predictors of achievement. Analysis indicated that it is the older students who possess many of the attributes that will equip them for future success. As a group, these older students demonstrated an internal locus of control and a learning style profile that reflects characteristics valued by graduate educators including high levels of motivation, persistence and responsibility, along with adaptability to varied learning environments and independent study skills. Results suggest that older students already have highly developed meta-cognitive processing skills. However, in most universities it is likely that the majority of first year students are not older students. Emerging evidence suggests that learning processes do play an important early role in directing student progress through the university. (Contains 33 references.) (JB)

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Students' Learning Processes and Progress in Higher Education

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Paper prepared for the American Educational Research Association
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Students' Learning Processes and Progress in Higher Education

Abstract

A complex system of student and instructional factors operates to influence academic achievement in higher education. A two-wave causal path model was developed using data collected over two years from 72 university students. The model was tested using partial least squares path analysis procedures in order to examine the relationships among 15 factors hypothesized to influence tertiary students' progress. Of the predictor variables included in the model (Tertiary Entry Score; Approach to Learning ; Learning Style; Age; Sex; Locus of Control; Metacognitive Capability; and students' Self-Rated Performance), learning process variables prove to be important factors in shaping students' progress in their first year. Achievement in first year then became the most powerful predictor of future performance. Relationships among the other variables also provide valuable information about students' learning processes and progress in higher education.

Students' Learning Processes and Progress in Higher Education

There is a growing body of research on students' learning processes that shows the relevance of this area to understanding and explaining why some students are more academically successful than others. In broad terms, learning processes refer to the ways in which students go about the tasks of learning and studying. The emphasis in this field of research, therefore, is more upon *how* students learn than *what* is learned (Biggs & Moore, 1993).

How students go about learning is a field of research that is undervalued in higher education. When students begin school a considerable amount of instructional time is given to building the process skills they need in order to master the content of their studies. For example, young children are taught how to read in order to be able to work as independent learners. Effective reading instruction involves not only interpreting printed words but also developing strategies to cope with the complexity of the language and the task, as well as understanding the content. Similarly, instruction in mathematics and writing includes process and content. Both have equally important roles to play in learning. As students proceed through school, proportionally less time is allocated to instruction in the strategies and skills that facilitate the learning of content, and more time is given to the content itself. By the time students enter higher education it is assumed they have learned not only a body of knowledge (content), but also how to learn (process). The result is that "the university curriculum is often dominated by content at the expense of the process of understanding" (Gardiner & Singh, 1991, p. 59).

Gardiner and Singh (1991) argue that university teaching is largely content driven with lecturing still the main teaching method, conducted in an expository mode. If, in fact, history students did know how to approach the study of history as an historian, or science students know how to understand science as a scientist, the concentration on content might not present a problem. However, problems arise when students who are not already equipped with the strategies and skills needed to meet the academic demands of their courses, have limited opportunities to confront their ineffective strategies and misconceptions. They are then "left guessing about lecturers' expectations and develop coping rather than learning strategies for getting through the course" (Gardiner & Singh, 1991, p. 84). Learning that emphasizes content also tends to focus on academic achievement in terms of mastery of that content, often without sufficient recognition that

learning is developmental, and that students who are new to a topic need more than subject content to assist them to grasp complex principles and concepts. An unfortunate consequence of this is that the difficulties students experience are generally regarded as an inability to master the content of their studies (Knapp, 1991). Somewhere between the elementary classroom, and the university lecture hall the link between process and content has been broken.

One way in which faculty can offer students a reasonable chance of success is to understand better students' learning processes. Notwithstanding the differences in ability between students that account for some of the difference in levels of achievement, there is support from research for differentiating successful from less successful students according to the learning and studying processes that they are able to generate and apply (McKeachie, 1988; Schmeck, 1988; Weinstein & Van Mater Stone, 1992). Weinstein and Van Mater Stone (1992) show that, in addition to knowing more, successful students are better able to organize and integrate their knowledge. They have more effective and efficient strategies for accessing, using, and applying their knowledge, and they do all these things in a more self-regulated or metacognitive manner.

While some of the strategic choices students make can be related to ability (McKeachie, Pintrich & Lin, 1985), attitudinal factors such as affect and motivation have also been found to moderate effective strategy use (McCombs, 1988; Zimmerman & Schunk, 1989). McCombs (1988) draws attention to a number of *self* attributes that are regarded as successful performance indicators. Among these, self-direction and self-regulation of learning and studying behavior are related to self-perceptions and self-efficacy (Zimmerman, 1989; Zimmerman & Martinez-Pons, 1988). These attributes can be identified in the independent learner, a student characteristic that is highly valued by university academics (Moses & Ramsden, 1992). In a more general sense, in studies where attitudes towards learning and studying such as motivations, interest in the subject matter of courses, and commitment are included, positive relationships are commonly found between high scores on attitudinal variables and high achievement outcomes (Biggs, 1987a; Minnaert & Janssen, 1992; Price, Dunn & Dunn, 1991).

In addition to these factors, two other constructs provide a further source of information on students' learning processes. The learning style construct, as it is presented in models developed by Dunn and Dunn (Dunn, 1990) and Keefe and Monk (1988), contains a range of variables that tap students' learning processes. Those that relate to motivation and affect

have been mentioned already. Learning style proponents hypothesize that these, and other sociological, cognitive, perceptual and physiological variables, comprise a student's relatively stable set of trait-like instructional and information processing preferences. There is evidence (Dunn, Deckinger, Withers & Katzenstein, 1990; Griggs, 1990) that students who develop learning and studying skills that are congruent with their preferences are more effectively able to manage their own learning. It seems also, that only a limited number of learning style characteristics are associated with tertiary success. This suggests that the university learning environment supports certain 'styles' and that those who possess other 'styles' are not catered for within the university system (Murray-Harvey, 1993).

Biggs (1987a), Entwistle and Entwistle (1991), and Trigwell and Prosser (1991), among other Approach to Learning theorists interested in the effects of students' learning processes on learning outcomes, have confirmed that students' adoption of either deep or surface approaches to learning (represented by their motives and strategies) have a subsequent effect on the quality of their learning. Outcomes associated with a surface approach are generally poor retention of subject content and a low level of conceptual understanding. This is because students adopt learning processes that are geared towards meeting the minimal requirements for passing a course, primarily through the reproduction of information. A deep approach results in a high level of conceptual understanding because students who adopt this approach to learning are intrinsically motivated: the learning processes they invoke include a search for meaning by reading widely and integrating new principles and concepts with prior learning. In addition, an achieving or strategic approach has been identified by Biggs (1987a) and Entwistle and Ramsden (1983) to characterize the self-management or organizational aspects of learning and studying.

Clearly, the relationships between the various factors that may affect student progress are complex. The predictive validity of prior performance on future success at university is reasonably well established (Minnaert & Janssen, 1992; Power, Robertson & Baker, 1987; Watkins, 1986). However, less information is available on the influence of students' learning processes, particularly their predictive power in relationship to other more generally accepted indicators of performance. Essentially, the many factors that are shown to influence performance do not operate in isolation from each other, yet there are few studies that examine the complexity of these relationships in terms of their direct and mediated influences on each other. The following study is designed to investigate the complex interrelationship of factors that affect tertiary students' academic achievement. A path model is constructed and tested which includes learning process variables in

conjunction with other, antecedent predictor variables, in order to determine their contribution to students' progress, to detect relationships that each construct has with others in the model and thus, to trace their direct and indirect effects on learning outcomes.

Method

Sample

The population used to develop the data set was 72 students who were enrolled in first year Nursing and Teacher Education courses in 1991 at The Flinders University of South Australia.

Design of the Path Model

From data gathered over two years, a two-wave path model was constructed to permit examination of the development of students' learning processes over time and in conjunction with other antecedent predictors of achievement. Each variable selected for inclusion in the model was drawn from previous research where that variable, in its own way, was shown to influence academic achievement.

The hypothesized model contained 16 latent variables and is presented in Figure 1. In the model, each latent variable is presented and numbered in order of its assumed influence on other variables in the model. Age and Sex are represented as exogenous variables and placed to the far left of the model as no other variables are hypothesized to influence them. Achievement 1992 is the criterion variable and is placed to the far right in the model. In the initial model, which specified a fully recursive model, all other latent variables (LVs) were hypothesized to influence Achievement 1992.

insert Figure 1 about here

The arrangement of latent variables in the model represents either a logical or chronological sequence of potential influences on final achievement. An individual's internal or external Locus of Control is regarded as a stable attribute which, without intervention, would be expected to remain relatively unchanged over time. The Tertiary Entrance Score (TES) is the level of performance assessed prior to entry to university and is the main criterion used for university selection. Therefore, these two LVs are depicted to the left of the model. Learning Style 1, Self-Rated Performance 1 (SRP1), and students' Approach to Learning - represented as their Motive 1 and Strategy 1, were obtained from students in the first weeks

of their first year at university. The latent variable SRP1 represents students' assessment of their performance relative to peers based on evaluations of prior learning performance. Similarly, Learning Style 1 and Approach to Learning (Motive 1 and Strategy 1) represent students' learning processes upon entry to university.

Previous research (Murray-Harvey, 1993) indicates that the relationship between Learning Style and Approach to Learning is that students' learning style influences their approach to learning. Learning style is argued to be a relatively stable characteristic of the person whereas a student's approach to learning is expected to change in response to the learning environment. In the same way, SRP can be argued logically to influence the formation of motives or intentions related to future performance. The relationship defined between motives and strategies is based on Biggs' (1987a) congruence hypothesis that motives influence strategies. Their placement in the model is consistent with Biggs' theory and with research indicating that Approach to Learning is best represented by Motive and Strategy depicted as separate constructs (Murray-Harvey, 1993).

Data on students' Metacognitive Capability were gathered later in the academic year and this variable is depicted in the model to illustrate the influence of the preceding predictor variables on Metacognitive Capability and in turn, its potential influence on achievement. Achievement 1991 represents the students' grade point average (GPA) for the first year of tertiary studies.

Learning Style 2, Self-Rated Performance 2 (SRP2), and Motive 2 and Strategy 2 data were obtained from students early in their second year at university.

A qualitative measure of student learning outcome was calculated using the Structure of the Observed Learning Outcome (SOLO) Taxonomy (Biggs & Collis, 1982), to determine the relationship of quality of learning outcome with the more traditional calculation of student performance based on GPA.

Partial least squares path analysis was performed using the PLSPATH version 3.01 program (Sellin, 1990) which provides jackknife standard error estimates. PLS version 1.8 (Lohmoeller, 1987) was used to obtain summary statistics to evaluate the strength and stability of the model.

insert Table 1 about here

A path model has inner and outer variables. The core of the model is a set of relations among the inner variables. The variables described above form the inner model. Indicators of these inner latent, or indirectly observed variables are the observed or manifest variables (MVs) which form the outer model. A description of the MVs (those on which data were gathered) with their means, standard deviations, and path estimates is given in Table 1. The arrows directed outwards from the LV indicate that the manifest variables reflect, rather than form, the particular latent variable construct. As the outward mode is specified in this model, the manifest variable path estimates are interpreted as factor loadings, and the LV is estimated using a canonical or factor analytic approach. When a latent variable is defined by only one manifest variable as in the case of Sex, TES, Age, Locus of Control, SRP, Metacognitive Capability, and the Achievement LVs, the PLS estimates of the factor loadings are always equal to unity (Unity Mode).

Procedures

The strength of PLSPATH is its heuristic use in testing the theoretical model, and initial models are subject to change in the light of data from the real world (Sellin & Keeves, 1994). The operation of partial least squares procedures is directed otwards the maximization of the explained variance of the endogenous latent variables in a model. The LVs represented in the hypothesized model (Figure 1) differ from those depicted in the final model (Figure 2). After initial testing for magnitude of effect, four LVs were considered not to contribute to explaining final achievement and were deleted from the model in subsequent analyses. These LVs are SRP 2, Motive 2, Strategy 2, and SOLO.

insert Figure 2 about here

Refining the Model

In refining a model the principles of parsimony and coherence apply. Parsimony relates to removing those variables from the model where the magnitudes of their effects are slight. Coherence is concerned with justification of an effect in terms of logic and chronology.

Procedures of testing for statistical significance are largely abandoned in the discussion that follows because such significance tests are heavily dependent on sample size. Furthermore, the group of students under survey do not represent a random sample from a well defined target population, but rather the complete population of students available for the study. As

a consequence, statistical inference must be considered inappropriate. In addition, since such significance tests depend upon assumptions of normality, which cannot be considered to apply to a variable such as Sex, and multivariate normality is unlikely to apply to all the latent variables included in the inner model, standard procedures of significance testing would seem unsound (Tuijnman & Keeves, 1994).

However, the computer program employed does permit the calculation of standard errors for each parameter estimated through the use of a jackknife procedure. The jackknife standard errors of the estimated path coefficients can be used to assess the magnitude of effect of a particular variable. In refining the path model presented in this paper two guiding rules were used with respect to the paths between latent variables in the inner model. First, a path coefficient had to exceed its standard error as estimated by the jackknife procedure. Secondly, a path coefficient had to exceed 0.10 in magnitude. which may be taken to indicate that its contribution to explanation accounts for excess of one per cent of the variance of the dependent latent variable involved.

In refining the paths between the latent variables and the manifest variables which they reflect, only one rule was used, namely that the estimated loadings must exceed twice their standard errors as estimated by the jackknife procedures. This yielded loadings in the final model in excess of 0.36 and the paths were associated with excess of ten per cent of explained variance.

With a larger, random sample that represented a well defined target population, and where a dichotomous variable such as sex was not involved in the model, then other rules for refining the model might well be advanced that involved testing for statistical significance.

Model Evaluation

The evaluation of a model in PLSPATH analyses is basically in terms of the proportion of variance explained (R^2). PLSPATH also provides the Q^2 statistic which is useful as a test criterion. It is derived as the jackknife analogue of R^2. A tested model has more predictive relevance the higher Q^2 is, and modifications to a model may be evaluated by comparing Q^2 values.

Results and Discussion

Even a cursory glance at the final model produced by PLSPATH analysis indicates than the relationships between the factors than influence academic progress are complex. Outer model results are considered first as they assist the interpretation of the inner model. Discussion of the inner model results is presented in two parts. First, causal relationships between latent variables exerting a direct effect on final achievement are considered. Following this, relationships between the Phase 1 variables are discussed. In addition, from PLS 1.8, the goodness of fit of the data to the model is provided by the Bentler-Bonett reliability coefficient and the root mean square of the covariance between outer model residuals and the latent variables (RMS Cov(E,U).

insert Table 2 about here

Table 2 contains a summary of the path coefficients obtained for the final, simplified model after trivial paths have been deleted. Direct effects (*p*) are shown for those LVs that have recognizable effects on other LVs in the model. Total effects (*t*) represent the sum of the direct and indirect effects. Indirect effects (*i*) are obtained by calculating the difference between the estimated total and direct effects. Latent variable correlations (*r*) are also reported. Figure 2 is a graphic representation of the final model showing non trivial path coefficients with their jackknife standard errors in parentheses.

As indicated by the overall explained variance of the criterion variable of Achievement 1992 in the model (R^2=0.66), the hypothesized factors collectively contribute substantially to explain final achievement. On average, 33 per cent of the variance of the endogenous latent variables in the model is explained. While the Q^2 statistics are low for some the latent variables in the model, Q^2 is relatively high for Achievement 1992 (Q^2=0.60) which indicates a high level of predictive relevance for this latent variable.

It should be noted that the direct path from Learning Style 2 to Achievement 1992 (*p*=0.06) is slight snd less than its standard error (*e*=0.09). As a consequence the LV Learning Style 2 is best removed from the model. This has no effect on the variance explained of Achievement 1992 (R^2=0.66) nor on the Q^2 statistic (Q^2=0.60), but the Bentler Bonett reliability index increases from (r_{tt}=0.38 to r_{tt}=0.50) and RMS Cov(E,U) falls from (0.078 to 0.074) indicating a better fitting model.

Relations Between Manifest Variables and Latent Variables

Learning Style

Of the 20 hypothesized learning style elements in the Dunn and Dunn model only eight were found to be important indicators of the Learning Style latent variable. The first three observed variables are from the *Emotional* category of the Dunn and Dunn model (Motivation, Persistence, and Responsibility) and can be interpreted as the students' commitment to their work. The next two describe *Environmental* study preferences, a need for bright Light and a formal Design (seating arrangement) when studying. Peers and Several Ways are *Sociological* preferences. Here, the negative loading on Peers indicates a strong preference for working alone and Several Ways relates to the ability to cope with a variety of instructional methodologies. Finally, Time of Day is a *Physiological* preference with the positive value on the loading indicating a preference for learning in the early morning. It is evident that the *Emotional* and *Sociological* indicators feature most strongly, and that learning style in Phase 1 of the model does not include the perceptual modalities.

A final point of interest that emerges from the findings related to Learning Style is that the three strongest indicators of Learning Style 1 (Motivation, Persistence, and Responsibility) are also the three strongest indicators of Learning Style 2. In fact, all the Learning Style MVs that reflect Learning Style 1 are represented as important indicators of Learning Style 2. The only variation in Learning Style between Phase 1 and Phase 2 of the model is that the Visual, Tactile, and Kinesthetic perceptual preferences produced non trivial loadings on Learning Style 2 whereas they did not load on Learning Style 1.

Approach to Learning

The three indicators which are employed in the reflective mode to indicate the latent variable of Motive (Surface, Deep, and Achieving motive) are measures of motives related to Approach to Learning (Biggs, 1987a). The loadings for Deep and Achieving Motive 1 are sizable while Surface Motive was found to make a trivial contribution to the Motive 1 construct in Phase 1 of the model. For the three measures which reflect the latent variable of Strategy (Surface, Deep, and Achieving strategy), the loadings again show that Deep and Achieving strategies are strong indicators of Strategy. Surface strategy also contributed substantially to the latent variable of Strategy 1 although much less than Deep and Achieving strategies.

Relations Between Latent Variables

The most striking finding of this study is the relationship between variables in Phase 1 and Phase 2 of the model. None of the explanatory LVs examined in Phase 2 of the model made any recognizable contribution to final achievement. This picture presents an obvious contrast to the early influence of these same variables on students' achievement in their first year of tertiary study. By the end of the students' first year, the effect of the grades they received far outweighed the influence of any other factors on student progress. Of all the variables in the model, the most powerful influence on final achievement was exerted by Achievement 1991 [p=0.71(07)]. Clearly, early success at university was the best guide to continued progress. Three other factors also meaningfully contributed to Achievement 1992. They were students' Age [p=0.15(0.08)] showing that older students were higher achievers; Self-Rated Performance 1 [p=0.13(0.10)] indicating that early self-assessments of competent performance were related to later success; and Motive 1 [p=0.10(09)] reflecting the relationship between deep-achieving motives and high grades.

As indicated by the relationships between variables in Phase 1 of the model, it is evident that students' learning processes in their first year of tertiary study were critical to achieving successful learning outcomes. In order of the magnitude of the LV direct (p) effects on Achievement 1991 were students' Metacognitive Capability [p=0.28(0.10)]; Learning Style [p=0.25(0.13)]; Age [p=0.25(0.11)]; TES [p=0.21(0.11)]; and their Locus of Control [p=-0.12(0.08)].

The students who were more metacognitive, that is, those who showed greater awareness of, and control over their learning processes, were the higher achievers. The importance of Metacognitive Capability as an influential learning process factor is demonstrated both by the direct effect (p=0.28) of this variable on Achievement 1991 and by the strength of its indirect effect (i=0.20) on Achievement 1992. The significance of this finding for tertiary educators is in their role in developing students' metacognitive processing skills. In essence, teaching can either foster or inhibit metacognitive processing. Lecturers who make explicit their expectations, explain the procedures and methods required for successful learning of subject content, and who offer strategies for learning and studying that are appropriate to the discipline, encourage metacognitive processing. The impact of strategy development is further revealed by the link between Strategy 1 and Metacognitive Capability [p=0.22(0.10)]. Not surprisingly, students with deep-achieving strategies were more metacognitive. This relationship supports Biggs' (1987a) finding that teaching which

encourages students to understand the material rather than merely reproduce information, and to organize their time and effort effectively, will promote metalearning.

With regard to Learning Style, the characteristics that best identify the high achievers are their high level of motivation, persistence and responsibility. In addition, these students are flexible learners who prefer to work alone and who possess characteristics identified as an analytic learning style (Dunn, 1990): this involves preference for bright vs dim light; formal vs informal design; and learning in the morning vs evening, when learning and studying.

The remaining three variables in this group show that successful first year students have higher TES scores, are older, and have an internal locus of control. Closer examination of relationships among these LVs reveals that older students have a more internal locus of control [p=-0.29(0.13)]. The direct effect of Age on Motive 1 [p=-0.25(10)] indicates that here, it is the younger students who have deep-achieving motives, However, Motive 1 does not play a significant role in influencing Achievement 1991 although it was noted earlier to have a weak but recognizable effect on Achievement 1992.

Of interest also, are relationships between these and other variables in the model that indicate indirect (i) influences on achievement. The most notable indirect influence is that of Age, both on Achievement 1991 (i=0.16) and Achievement 1992 (i=0.27). In addition, Age has a recognizable indirect effect on Learning Style (i=0.12). There is also a sizable indirect effect of TES on Achievement 1992 largely through Achievement 1991 (i=0.22). It appears that the TES score remains a reasonably strong predictor of student success at university.

Although Learning Style 2 did not contribute to final achievement the LV is shown in the final model presented in Figure 2 to indicate the relative stability of learning style over time. In fact, each of the Phase 1 LVs produced a strong path coefficient to its corresponding Phase 2 LV indicating that motives, strategies, self-rated performance as well as learning style, remain relatively stable over time. This suggests that while the variables represented in Phase 2 of the model did not make a significant contribution to Achievement 1992, when other factors were taken into account, their effect on student progress should not be ignored. The reduced impact of Phase 2 LVs on final achievement is largely a consequence of the more powerful influence of the Phase 1 LVs and the substantial effect of Achievement 1991 on Achievement 1992.

Conclusion

The findings of this study have important practical implications for teaching in higher education. The path model produced by partial least squares path analysis indicates that it is the older students in this setting who possess many of the attributes that will equip them for future success. As a group, they have an internal locus of control and a learning style profile that reflects characteristics valued by tertiary educators - high levels of motivation, persistence and responsibility, along with adaptability to varied learning environments and independent study skills. Most importantly, these older students already have highly developed metacognitive processing skills. However, in most universities it is likely that the majority of first year students are younger rather than older. In light of the emerging evidence: that learning processes do indeed play an important, early role in directing student progress through university, the best time to offer academic support to students is in their first year. The tendency for students to receive support after they have been deemed 'at risk' is rather like 'closing the stable door after the horse has bolted'.

If teachers of first year students consider providing information on *how* to learn their subject effectively as well as the content material, they may be able to circumvent many of the difficulties that may impede students' academic progress.

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Table 1

Path Model: List of All Observations

Variables Description and Coding (N=72)	Mean	SD	*PLS Estim
AGE [unity mode]			
Age of Student At March,1991 17-52 years	22.83	7.91	1.00
SEX [unity mode]			
Sex of Student Male=1; Female=2	1.83	.36	1.00
ACHIEVEMENT 1991 [unity mode]			
Students' grade point average (GPA) for 1991	2.28	.63	1.00
ACHIEVEMENT 1992 [unity mode]			
Students' grade point average (GPA) for 1992	2.48	.65	1.00
TES (Tertiary Entrance Score) [unity mode]			
University selection score out of 500. Based on school results or equivalent converted scores.	329	30.00	1.00
SRP 1 (Self-Rated Performance) [unity mode]			
Student *self-rating* of performance relative to peers in 1991. 1=Quite Poor to 5=Excellent	3.24	.52	1.00
SRP 2 (Self-Rated Performance) [unity mode]			
Student *self-rating* of performance relative to peers in 1992. 1=Quite Poor to 5=Excellent	3.55	.62	1.00
LOCUS of Control [unity mode]			
Internal locus scores low indicated by negative value and external locus scores high indicated by positive value. Locus of Control of Behaviour Scale (Craig, Franklin & Andrews, 1984)	25.99	7.64	1.00
METACOGNITIVE CAPABILITY [unity mode]			
Metacognitive Capability 10-point scale measuring awareness and control of learning processes: 1=very low to 10=very high	5.92	1.16	1.00
SOLO [unity mode]			
SOLO score Adapted from the Structure of the Observed Learning Outcome (SOLO) Taxonomy (Biggs & Collis, 1982) 5-point rating scale: 1=prestructural, 2=unistructural, 3=multistructural, 4=relational, 5=extended abstract.	3.15	.65	1.00
MOTIVE 1 (1991) (Approach) [outward mode]			
Surface Motive (SM)	6.68	2.47	*
Deep Motive (DM)	6.44	2.64	77
Achieving Motive (AM)	7.64	2.41	87
STRATEGY 1 (1991) (Approach) [outward mode]			
Surface Strategy (SS)	6.40	2.65	58
Deep Strategy (DS)	6.33	2.64	85
Achieving Strategy (AS)	8.24	2.05	85

Table continues

Table 1 (continued)

Path Model: List of All Observations

Variables description & coding		Mean	SD	*PLS Estim.
MOTIVE 2 (1992) (Approach) [outward mode]				
Surface Motive (SM)		6.31	2.67	*
Deep Motive (DM)		6.21	2.93	91
Achieving Motive (AM))		7.18	2.56	89
STRATEGY 2 (1992) (Approach) [outward mode]				
Surface Strategy (SS)		5.42	2.72	*
Deep Strategy (DS)		5.79	2.87	86
Achieving Strategy (AS)		7.22	2.64	90
LEARNING STYLE 1 (1991) [outward mode]				
Sound	Prefers sound when studying	51.48	8.93	*
Light	Prefers bright light when studying	52.03	7.41	.37
Temperature	Prefers cool environment	49.10	7.78	*
Design	Prefers formal seating arrangement (table,chair)	50.47	8.61	.41
Motivation	Maintains a high level of interest	49.62	6.37	.79
Persistence	Stays 'on task' until work complete	50.30	6.29	.66
Responsibility	Conforms to expectations	45.21	8.61	.82
Structure	Needs direction rather than latitude	62.68	5.94	*
Peers	Prefers to study alone rather than with peers	52.16	8.23	.49
Authority	Needs direction from 'expert'	55.90	7.72	*
Several Ways	Learns in varied ways	50.90	8.96	.49
Auditory	Learns by listening/hearing	54.86	7.52	*
Visual	Learns by watching/reading	51.61	5.87	*
Tactile	Learns by hands-on/notetaking	51.32	7.13	*
Kinesthetic	Learns by active involvement	50.99	4.77	*
Intake	Does not need to eat/drink to help concentration	53.78	8.06	*
Time Day	Prefers to concentrate in the morning	47.10	7.43	.36
Late Morning	Concentrates best late morning	48.01	7.45	*
Afternoon	Concentrates best in the afternoon	55.38	9.88	*
Mobility	Able to sit still for long periods	53.48	7.13	*
LEARNING STYLE 2 (1992) [outward mode]				
Sound	Prefers sound when studying	51.57	8.02	*
Light	Prefers bright light when studying	53.53	8.07	.52
Temperature	Prefers cool environment	48.44	9.42	*
Design	Prefers formal seating arrangement (table,chair)	50.38	9.32	.65
Motivation	Maintains a high level of interest	47.83	8.73	.82
Persistence	Stays 'on task' until work complete	50.29	8.02	.73
Responsibility	Conforms to expectations	43.53	9.82	.73
Structure	Needs direction rather than latitude	62.11	7.68	*
Peers	Prefers to study alone rather than with peers	52.57	10.70	.48
Authority	Needs direction from 'expert'	52.83	8.85	*
Several Ways	Learns in varied ways	47.89	9.28	.66
Auditory	Learns by listening/hearing	51.79	8.92	*
Visual	Learns by watching/reading	50.57	7.67	.47
Tactile	Learns by hands-on/notetaking	51.63	8.83	.46
Kinesthetic	Learns by active involvement	49.88	7.13	.57
Intake	Does not need to eat/drink to help concentration	54.93	9.36	*
Time Day	Prefers to concentrate in the morning	46.33	9.52	.36
Late Morning	Concentrates best late morning	47.29	10.35	*
Afternoon	Concentrates best in the afternoon	57.17	10.58	*
Mobility	Able to sit still for long periods	52.57	8.43	*

* PLSPATH Estimation reported as factor loadings for outward mode. Loadings <2 x Se are not reported.
Note: Standard scores provided for Learning Style (Mean=50, SD=10) and decile scores for Approach to Learning (Biggs, 1987b).

Table 2

Latent Variables: Direct Indirect and Total Effects

Variables	Direct Effects (p)	Jackknife SE	Total Effects (t)	Indirect Effects (i)	Corr (r)
Achievement 1992					
Sex	*	*	.06	.06	.23
Age	.15	.08	**.42**	**.27**	.44
Locus of Control	*	*	**-.21**	**-.21**	-.30
TES	*	*	**.22**	**.22**	.31
Learning Style1	*	*	**.26**	**.26**	.45
Self-Rated Performance 1	.13	.10	**.15**	.02	.14
Motive1	.10	.09	**.12**	.02	.20
Strategy1	*	*	.04	.04	.28
Metacognitive Capability	*	*	**.20**	**.20**	.45
Achievement 1991	.71	.07	**.71**	*	.78
Variance explained: R^2=0.66 Q^2=0.60					
Achievement 1991					
Sex	*	*	.07	.07	.22
Age	.24	.11	**.40**	**.16**	.44
Locus of Control	-.12	.08	**-.23**	**-.11**	-.34
TES	.21	.11	**.30**	.09	.33
Learning Style1	.25	.13	**.27**	.03	.42
Self-Rated Performance 1	*	*	.01	.01	-.02
Motive1	*	*	.03	.03	.13
Strategy1	*	*	.06	.06	.26
Metacognitive Capability	.28	.10	**.28**	*	.46
Variance Explained: R^2=0.45 Q^2=0.34					
Motive1					
Sex	*	*	**.10**	**.10**	.16
Age	-.25	.10	**-.19**	.06	-.18
Locus of Control	*	*	**-.19**	**-.19**	-.13
TES	*	*	.07	.07	-.02
Learning Style1	.36	.13	**.40**	.04	.37
Self-Rated Performance 1	.18	.11	**.18**	*	.27
Variance explained: R^2=0.22 Q^2=0.14					
Strategy 1					
Sex	*	*	**.11**	**.11**	.22
Age	*	*	-.08	-.08	.04
Locus of Control	*	*	**-.20**	**-.20**	-.15
TES	*	*	.08	.08	-.01
Learning Style1	.23	.09	**.45**	**.22**	.44
Self-Rated Performance 1	*	*	.01	.01	.20
Motive1	.55	.10	**.55**	*	.64
Variance explained: R^2=0.45 Q^2=0.41					

Table continues

Table 2 (continued)

Latent Variables: Direct Indirect and Total Effects

Variables	Direct Effects (p)	Jackknife SE	Total Effects (t)	Indirect Effects (i)	Corr (r)
Learning Style1					
Sex	.24	.14	**.24**	*	.23
Age	*	*	**.12**	**.12**	.18
Locus of Control	-.42	.10	**-.42**	*	-.41
TES	.17	.11	**.17**	*	.21
Variance explained: R^2=0.26 Q^2=0.16					
Learning Style2					
Sex	*	*	**.17**	**.17**	.11
Age	*	*	**.16**	**.16**	.22
Locus of Control	*	*	**-.29**	**-.29**	-.39
TES	*	*	**.15**	**.15**	.24
Learning Style1	.67	.07	**.69**	.02	.70
Self-Rated Performance 1	*	*	*	*	.25
Motive1	*	*	.03	.03	.20
Strategy1	*	*	.05	.05	.37
Metacognitive Capability	.22	.08	**.22**	*	.31
Variance explained: R^2=0.54 Q^2=0.50					
Metacognitive Capability					
Sex	*	*	.02	.02	.10
Age	.35	.13	**.34**	**-.16**	.36
Locus of Control	*	*	-.04	-.04	-.14
TES	.15	.10	.02	.02	.17
Learning Style1	*	*	**.10**	**.10**	.16
Self-Rated Performance 1	*	*	.02	.02	.02
Motive1	*	*	**.12**	**.12**	.01
Strategy1	.21	.10	*	*	.20
Variance explained: R^2=0.19 Q^2=0.09					
Self-Rated Performance 1					
Sex	*	*	.05	.05	-.04
Age	*	*	.07	.07	.02
Locus of Control	-.16	.11	**-.25**	-.09	-.25
TES	*	*	.03	.03	-.07
Learning Style 1	.21	.17	**.21**	*	.28
Variance explained: R^2=0.10 Q^2=0.009					
Locus of Control					
Age	-.29	.13	**-.29**	*	-.29
Variance explained: R^2=0.08 Q^2=0.018					

Bolded figures indicate sizeable Total and Indirect Latent Variable effects. * Paths with coefficients <1 x Se not reported.
Note: LVs with all paths <1 x Se or less than 0.10 are not reported.
Note: Negative value for locus of control denotes greater internality

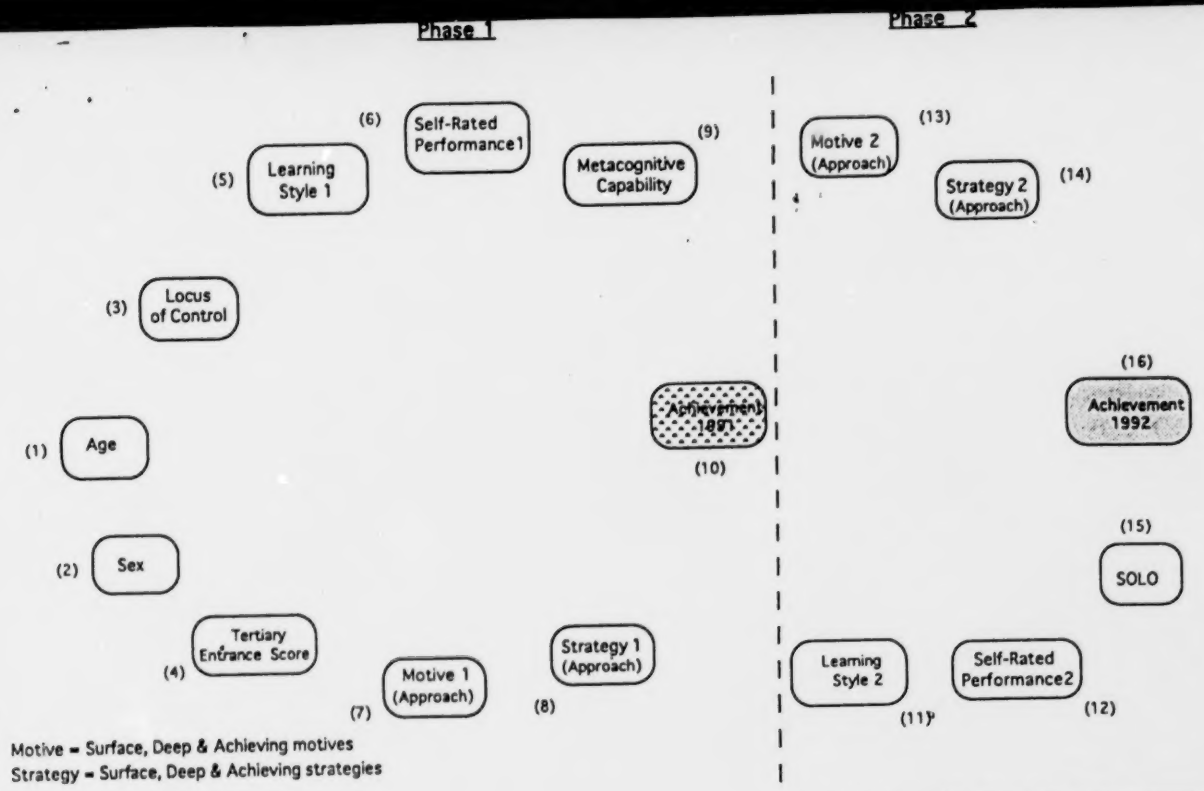

Figure 1. Hypothesized model of factors influencing student progress.

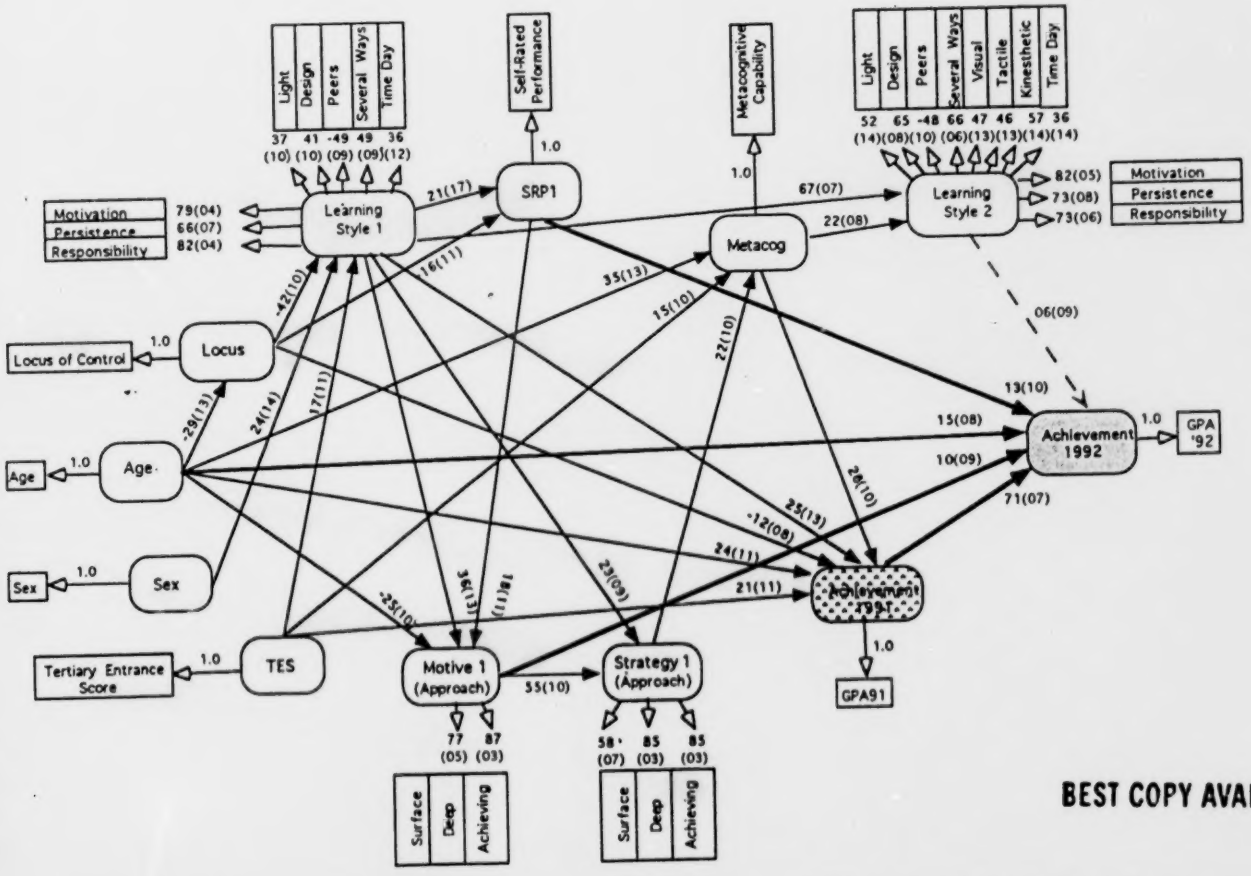

Figure 2. Final model of factors influencing student progress

Note: Decimal points omitted

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